Summary Highlights of NRC/DOE Technical Exchange and Management Meeting on Total System Performance Assessment and Integration

August 6-10, 2001
Las Vegas, Nevada

Introduction and Objectives

This Technical Exchange and Management Meeting on Total System Performance Assessment and Integration (TSPAI) is one in a series of meetings related to the U.S. Nuclear Regulatory Commission (NRC) key technical issue (KTI) and sufficiency review, and the U.S. Department of Energy (DOE) site recommendation decision. Topics within TSPAI KTI have been discussed in two separate technical exchanges. The first technical exchange, conducted on May 15-17, 2001, focused on the NRC review and comments regarding part of the scenario analysis subissue, specifically the screening of features, events, and processes (FEPs) from the performance assessment. The August 6-10, 2001, technical exchange focused on the remaining portions of the scenario analysis subissue, and the remaining subissues within the TSPAI KTI.

Consistent with NRC regulations on prelicensing consultations and a 1992 agreement with the DOE, staff-level resolution can be achieved during prelicensing consultation. The purpose of issue resolution is to assure that sufficient information is available on an issue to enable the NRC to docket a proposed license application. Resolution at the staff level does not preclude an issue being raised and considered during the licensing proceedings, nor does it prejudge what the NRC staff evaluation of that issue will be after its licensing review. Issue resolution at the staff level, during prelicensing, is achieved when the staff has no further questions or comments regarding how the DOE is addressing an issue. The discussions recorded here reflect NRC's current understanding of the TSPAI KTI. This understanding is based on all information available to date which includes limited, focused, risk-informed reviews of selected portions of recently provided DOE documents (e.g., Analysis and Model Reports (AMRs) and Process Model Reports (PMRs)). Pertinent additional information (e.g., changes in design parameters) could raise new questions or comments regarding a previously resolved issue.

NRC discussed the issue resolution definitions in the beginning of the meeting. Specifically, NRC stated that issues are "closed" if the DOE approach and available information acceptably address staff questions such that no information beyond what is currently available will likely be required for regulatory decision making at the time of any initial license application. Issues are "closed-pending" if the NRC staff has confidence that the DOE proposed approach, together with the DOE agreement to provide the NRC with additional information (through specified testing, analysis, etc.) acceptably addresses the NRC's questions such that no information beyond that provided, or agreed to, will likely be required at time of initial license application. Issues are "open" if the NRC has identified questions regarding the DOE approach or information, and the DOE has not yet acceptably addressed the questions or agreed to provide the necessary additional information in a potential license application.

Summary of Meeting

At the close of the Technical Exchange and Management Meeting, the NRC stated that Subissues 1, 2, and 4 are closed-pending and Subissue 3 is open. Subissue 3 remains open soley because there are open items within Subissue 2 (igneous consequences) of the Igneous Activity KTI. If, in a future Igneous Activity meeting, the status of Igneous Activity Subissue 2 were to change to closed-pending, the TSPAI Subissue 3 would be classified as closed-pending. The NRC/DOE agreements made at the meeting are provided in Attachment 1. A table containing all the FEPs discussed during the May 15-17 and August 6-9, 2001, meetings, and their associated NRC/DOE agreed upon path forward is included in Attachment 2. A table containing the modifications made to Unsaturated and Saturated Flow Under Isothermal Conditions Agreements 4.01 through 4.05 is included in Attachment 3. The agenda and the attendance list are provided in Attachments 4 and 5, respectively. Copies of the presenters' slides are provided in Attachment 6. Highlights from the Technical Exchange and Management Meeting are listed below.

Highlights

1) NRC Opening Presentation

In its opening comments, NRC provided a general overview of the TSPAI KTI (see "Overview of Total System Performance Assessment and Integration Meeting" presentation given by James Firth). NRC stated that the performance assessment, which is a systematic analysis of what could happen at a repository, is one of many NRC safety requirements. NRC also defined terms that would be used during the meeting and indicated that additional general information on performance assessment and on the NRC and its role in the potential Yucca Mountain high-level waste repository was available. The NRC then discussed the four subissues within the TSPAI KTI and stated that it had questions in all four subissues which had been given to DOE in preparation for the meeting. The NRC also discussed the use of risk insights in TSPA. Specifically, the NRC presented its position and expectations regarding the use of risk insights to address issues and concerns in a TSPA. Finally, the NRC noted that compliance with the proposed standards at 10 CFR Part 63 for individual and groundwater protection and multiple barriers is not considered in pre-licensing issue resolution; however, the methodology for evaluating the overall performance objective is considered in this context.

2) DOE Opening Presentation

DOE provided information regarding the status of all the other KTI subissues, the TSPAI KTI subissue status, and an overview of the FEPs technical exchange (see "Total System Performance Assessment and Integration" presentation given by Timothy Gunter). DOE stated that all the KTI subissues are closed or closed-pending except for Igneous Activity Subissue 2 and all four TSPAI subissues. DOE proposed a separation of the open Igneous Activity subissue from the TSPAI subissues. NRC commented that it could not separate the igneous activity issues from the TSPAI, however, it would state in the meeting summary, if appropriate, that the open issues within the Igneous Activity KTI were the only reason the TSPAI subissue(s) remained open. If, in a future Igneous Activity meeting, the Igneous Activity Subissue 2 changed status to closed-pending, then, at that point, the TSPAI subissue(s) could be classified as closed-pending.

DOE noted that during the May 15-17, 2001, meeting on scenario analysis, preliminary agreements were reached related to TSPAI Subissue 2, Scenario Analysis, and that those preliminary agreements would need to be formalized in this meeting. DOE also stated the discussions during this and the May meeting would support closed-pending of the TSPAI subissues (with the exception being the igneous activity issues within TSPAI Subissue 3). NRC indicated that resolution of the model abstraction subissue would involve adequately addressing all five of the generic acceptance criteria.

3) TSPAI KTI Subissue 2 - Scenario Analysis

DOE provided an overview of its plans to enhance FEPs evaluations (see "Total System Performance Assessment and Integration Key Technical Issue Subissue 2 - Scenario Analysis; Features, Events, and Processes Enhancements" presentation given by Geoff Freeze). DOE stated that it would address specific NRC concerns with the current FEP process, specifically, the level of detail in FEPs, use of secondary FEPs, FEPs versus modeling issues, and evaluating potential new FEPs.

DOE discussed its approach for identification and screening of FEPs. DOE stated that its approach would be presented in two parts. First, DOE discussed Phase 1 (what had been done to date), and noted that this same information had been presented during the May meeting. DOE summarized Phase 1 by stating the primary FEPs encompass a comprehensive set of technical issues relevant to post-closure repository performance. DOE noted that Phase 1 results are documented in the Yucca Mountain FEP database. DOE then discussed Phase 2 and stated additional FEPs may be identified prior to license application from new information or as the design progresses. DOE stated project configuration controls will be enhanced to identify FEP linkages to ongoing work and design changes. DOE also noted that potential changes to FEPs will be evaluated and documented using a multi-step approach. NRC questioned whether the multi-step approach will be documented in a procedure. DOE confirmed that it would be.

DOE then discussed the level of detail for primary FEPs. DOE stated that FEPs defined too specifically may produce too many low-probability (not credible) screening decisions. DOE also stated that FEPs defined too broadly may obscure important components and some components may be overlooked. NRC asked about the DOE approach for determining the level of detail of FEPs. DOE stated that if a technical basis could be developed which covered all the components of the FEP, then the FEP was not too broad. However, if the technical basis requires multiple screening arguments, it may be more appropriate to divide the FEP into two or more FEPs. DOE stated that an adequate level of detail for a FEP will be based on importance and complexity of the FEP. DOE also discussed (1) coarse FEPs which are characterized by low importance and/or complexity and broad detail, (2) specific FEPs which are characterized by high importance and/or complexity and specific detail, and (3) modeling issues which are at a finer level of specificity than is necessary or practical to develop a technically sound screening decision.

DOE then discussed FEP enhancements under consideration. DOE stated that it would revise the FEP descriptions to: (1) better identify all components included in a FEP; (2) ensure full incorporation of relevant FEP issues; (3) eliminate use of secondary FEPs terminology, yet

retain traceability to the Nuclear Energy Agency database or other source documents; and (4) make the level of detail more consistent, where possible. DOE stated that it would be developing "level of detail" criteria. NRC questioned when the development of the criteria would be completed. DOE stated work is ongoing and the criteria would be completed in the near future. NRC asked whether the level of detail criteria would be carried into the existing FEP database. DOE confirmed that they would be. DOE stated that they plan to revise (1) the screening arguments for excluded FEPs to improve technical basis descriptions and identify components, and (2) TSPA dispositions for included FEPs to improve the description of how components are included in TSPA. Finally, DOE stated that possible improvement for the purpose of better traceability include mapping, FEPs to TSPA keywords, and establishing a FEP components searchable index. NRC asked how the FEPs database would be used to track the disposition and incorporation of FEPs. DOE stated that the database will summarize the technical basis for the FEP and reference supporting documents for a more detailed technical basis.

After providing the overview for the scenario analysis subissue, NRC and DOE discussed several specific FEPs (see "Analysis of Resolution Status Key Technical Issue: Total System Performance Assessment and Integration - Subissue 2: Scenario Analysis" table). A number of comments pertained to Assumption 11 (geochemical effects as a function of distance from the drift) in the Features, Events, and Processes in Unsaturated Zone Flow and Transport AMR. In each case, the NRC noted this assumption was not verified and needed further verification prior to any potential license application. NRC and DOE discussed each FEP and agreed on a path forward (see Attachment 1 for NRC/DOE agreements).

After additional discussions, NRC and DOE reached eight agreements for TSPAI Subissue 2. With these agreements, the NRC stated that Subissue 2 can be classified as closed-pending.

4) TSPAI KTI Subissue 3 - Model Abstraction

DOE stated that the objectives of this presentation were to describe: (1) the current model development approach; (2) the TSPA model verification and validation approach; (3) the approach to ensure data and model uncertainty have been appropriately considered; and (4) the approach to provide transparency and traceability of the TSPA model and analyses (see "Total System Performance Assessment and Integration Key Technical Issue Subissue 3 - Model Abstraction" presentation given by Jerry McNeish).

DOE then discussed TSPA model development and stated that the TSPA is based on data, models, and analyses developed for engineered and natural barrier components of the system. The model development was completed under a quality assurance program and a systematic process was used for inclusion and exclusion of FEPs. DOE further stated that consideration of alternate conceptual models is conducted at the process level and was previously discussed at past technical exchange and management meetings. NRC questioned how DOE decided which alternative conceptual models were included in the performance assessment and what criteria were used for selection. DOE stated that process modelers make the decision which models are included into the TSPA and that this is discussed in the appropriate AMRs and PMRs. NRC expressed that it may be important to assess or represent model uncertainty in the performance assessment. NRC also questioned the meaning of statements regarding "testing of abstractions" and "coupling in TSPA model tested to ensure transfer of appropriate

information." DOE stated that the first issue case implied validation and the second case implied verification. DOE also indicated that the corrective actions being planned for Corrective Action Report (CAR) BSC-01-C-001 on model validation represents the DOE validation/verification path forward.

DOE presented information on model verification and validation. DOE stated that a submodel used to provide abstractions to the TSPA should be verified and validated in the appropriate AMRs. DOE stated that the TSPA model is verified and validated in multiple ways. For example: (1) the TSPA model software (GoldSim) is verified by the developer; (2) inputs to the TSPA model are checked to ensure they are used for their intended purpose and are working properly in the TSPA model; and (3) coupling in the TSPA model is tested to ensure transfer of appropriate information. NRC noted that all the examples appear to focus only on verification activities and, therefore, questioned which of the examples represent validation activities. DOE stated that the examples are mostly verification, and they are investigating how to validate the integrated TSPA model.

DOE then discussed data and model uncertainty. DOE discussed the types of uncertainty, the techniques to characterize uncertainty, uncertainty evaluation results, and model discretization. NRC asked how uncertainty is carried from process models to the TSPA. NRC also questioned how GoldSim was evaluated for errors when running the TSPA application (since the TSPA application is larger and more complex than typical applications of GoldSim). DOE responded that it intends to develop a guidance document to systematically evaluate the results of the TSPA code to identify possible computational problems.

DOE then discussed transparency and traceability. DOE stated that transparency and traceability is a priority throughout the program and transparency/traceability tools are being developed, including model flow charts, data source flow to model, simplified TSPA model, and additional graphics/visualization. NRC questioned whether DOE would integrate the FEP process and model abstraction transparency and traceability tools. DOE stated that it would use the model abstraction transparency/traceability tools extensively. DOE indicated plans to use an international review team and external oversight bodies to conduct transparency and traceability reviews. NRC asked if the composition of the international review team and external oversight bodies would be able to provide an appropriate balance between transparency and traceability. DOE indicated that the review team consists of only technical experts and no quality assurance experts. DOE had established the review to conduct a technical review of methodology, not to evaluate traceability. NRC pointed out, and DOE acknowledged, that quality assurance experts are needed to emphasize traceability.

DOE stated that limited alternative conceptual models have been evaluated within TSPA. To assess all alternative conceptual models, one has to consult individual AMRs. DOE indicated that improvements will be made to the documents to reflect comprehensiveness of the consideration of alternative conceptual models in TSPA.

NRC noted that all of its model abstraction comments reflect the five generic acceptance criteria discussed in the TSPAI Issue Resolution Status Report, Rev 3. NRC also noted that the identification numbers for all of its model abstraction comments contain the related acceptance criteria (e.g., ENG2.1.3 refers to comment number 3 under acceptance criterion 1 related to the Mechanical Disruption of Engineered Barriers model abstraction).

5) NRC Presentations on Waste Package Corrosion Rates

NRC provided two presentations on waste package corrosion rates. The first presentation discussed the experimental support of corrosion rates and implementation of the corrosion degradation model (see "Questions on Experimental Support of Corrosion Rates and General Corrosion Model Abstraction" presentation by Osvaldo Pensado). The specific questions discussed during the first half of the presentation were: (1) why creviced samples yield higher corrosion rates, and (2) why corrosion rates tend to decrease with test duration. The second half of the presentation addressed the evaluation of the DOE model abstraction on general corrosion. NRC independent modeling produced results consistent with results of the general corrosion model reported in TSPA-SR. Deficiencies in the DOE documentation were discussed and it was suggested to enhance the transparency of the description of the implementation of the waste package degradation model in areas related to thermal aging and corrosion from the inside-out. NRC stated that questions raised during the presentation would be covered during the discussions of the individual model abstractions.

In its second presentation, NRC discussed the effects of uncertainty/variance partitioning (see "Effects of Uncertainty/Variance Partitioning" presentation given by Richard Codell). NRC indicated that the treatment of parameter variability can make an important difference in the results in terms of the peak-of-the-mean dose, but it depends on the values of the parameters. Over a range of release rates, treating corrosion rates as real spatial variability led to the highest dose. For very slow release rates, there was little difference between the treatment of corrosion rate as either uncertain or variable. DOE asserted that the treatment of corrosion rate data as all uncertainty or all variability made little difference in peak dose was likely correct, because their release rates were slow. The NRC also concluded that the problem, in general, cannot be ignored because it can lead to risk dilution and an underestimation of consequences. The NRC expressed concern that the DOE representation of 100% uncertainty and 100% variability may not be similar to the NRC representations, therefore the NRC concern will need further evaluation.

6) Specific NRC Model Abstraction Comments

NRC and DOE discussed the NRC model abstraction comments organized within the 14 integrated subissues (see "Analysis of Resolution Status Key Technical Issue: Total System Performance Assessment and Integration, Subissue 3: Model Abstraction slides). See the slides for the specific NRC comments and DOE responses. Any agreements coming out of the discussions are highlighted below.

<u>ENG1 - Degradation of Engineered Barriers</u>

NRC and DOE discussed the NRC comments pertaining to the Degradation of Engineered Barriers model abstraction. To complement the ENG1.3.x specific comments, NRC added a general discussion on the treatment of data uncertainty to emphasize the importance of how uncertainty is passed to and used in TSPA. NRC questioned how specific sources of uncertainty, which may be important to conclusions of waste package and drip shield performance, were represented in the TSPA. These specific sources of uncertainty included: (1) the uncertainty from measured creviced and weight-loss samples general corrosion rates

and the statistical differences between the populations, (2) the uncertainty from alternative explanations for the decrease in corrosion rates with time (such as silica coatings that could alter the reactive surface area), (3) the uncertainty from utilizing a limited number of samples to define the correction for silica precipitation, (4) the confidence in the corrosion rate upper limit resulting from the limited sample size, and (5) the uncertainty from alternative statistical representations of the population of empirical general corrosion rates. DOE and NRC reached agreement TSPAI.3.01 to address the propagation of important sources of uncertainty (including those described above, if applicable) into future performance assessment calculations. NRC also questioned how epistemic or "lack of knowledge" uncertainty in waste package performance calculations might influence assessments of repository performance. NRC and DOE reached agreement (TSPAI.3.04) to address this concern. Overall, five specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.01 through 3.05). The agreements emphasized uncertainties and model abstraction as the overall technical bases of the waste package and drip shield degradation models were covered in the Container Life and Source Term and Evolution of the Near-Field Environment technical exchange agreements.

ENG2 - Mechanical Disruption of Engineered Barriers

NRC and DOE discussed the NRC comments pertaining to the Mechanical Disruption of Engineered Barriers model abstraction. One specific NRC/DOE agreement was reached in this area (see Attachment 1 - TSPAI Agreement 3.06). The NRC noted that comment ENG2.1.2 and ENG2.2.2 address concerns that were discussed during the June 21-22, 2001, technical exchange and management meeting on Igneous Activity. NRC proposed agreements in these areas at the June 2001 meeting, but NRC and DOE were not able to reach agreement. These items will be kept open and the NRC and DOE plan to discuss them again in a future Igneous Activity meeting.

ENG3 - Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms

NRC and DOE discussed the NRC comments pertaining to the Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms model abstraction. In particular, the NRC and DOE discussed the observations of moisture originating from rockbolts in the ECRB. DOE stated that they are currently evaluating the origination of this moisture and preliminary results suggest it is condensate. The NRC and DOE developed agreement TSPAI.3.07 to assess, if necessary, the impact of this moisture on hydrology, chemistry, and other applicable models. Overall, seven specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.07 through 3.13).

ENG4 - Radionuclide Release Rates and Solubility Limits

NRC and DOE discussed the NRC comments pertaining to the Radionuclide Release Rates and Solubility Limits model abstraction. The NRC and DOE discussed the consistent use of an EQ3/6 thermodynamic database throughout the Yucca Mountain Project. The NRC expressed concern that geochemical modeling being completed should use a consistent set of fundamental information. The NRC and DOE reached agreement TSPAI.3.15 for DOE to define a reference EQ3/6 geochemical database for the Yucca Mountain Project. DOE also agreed to provide documentation of all deviations from the reference database and justification

for those deviations on different geochemical modeling activities. Overall, five specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.14 through 3.17 and TSPAI.3.42). The agreements emphasized uncertainties and model abstraction, since overall technical bases were covered in the Container Life and Source Term and Evolution of the Near-Field Environment technical exchange agreements.

UZ1 - Climate and Infiltration

NRC and DOE discussed the NRC comments pertaining to the Climate and Infiltration model abstraction. Four specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.18 through 3.21).

UZ2 - Flow Paths in the Unsaturated Zone

NRC and DOE discussed the NRC comments pertaining to the Flow Paths in the Unsaturated Zone model abstraction. Six specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.22 through 3.27).

UZ3 - Radionuclide Transport in the Unsaturated Zone

NRC and DOE discussed the NRC comments pertaining to the Radionuclide Transport in the Unsaturated Zone model abstraction. Two specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.28 through 3.29).

Following this discussion, NRC and DOE discussed an NRC letter dated June 20, 2001, pertaining to the Unsaturated and Saturated Flow Under Isothermal Conditions KTI agreements. The NRC and DOE agreed to modify USFIC Agreements 4.01, 4.02, 4.03, 4.04, and 4.05 (see Attachment 3). In addition, DOE stated that the effects of water table rise on groundwater flux will be addressed in the Saturated Zone Flow and Transport Process Model Report and the Uncertainty Distribution for Stochastic Parameters AMR, as well as part of USFIC Agreement 5.04.

SZ1 - Flow Paths in the Saturated Zone

There were no NRC comments on the Flow Paths in the Saturated Zone model abstraction.

SZ2 - Radionuclide Transport in the Saturated Zone

NRC and DOE discussed the NRC comments pertaining to the Radionuclide Transport in the Saturated Zone model abstraction. NRC asked DOE if changes in radionuclide concentration in the saturated zone model in the TSPA changes as a result of the inclusion of FEP 2.2.08.01.00, Groundwater Chemistry/Composition in Unsaturated Zone and Saturated Zone. DOE responded that the code did not simulate changes in radionuclide concentration in the saturated zone. Individual realizations included spatially variable k_Ds only through the distinction between volcanic and alluvium units, but temporally constant K_D values. The NRC exressed concern that the TSPA code would not show potential increases in dose if the K_D decreased in the future. Three specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.30 through 3.32).

DIRECT1 - Volcanic Disruption of Waste Package

NRC and DOE discussed the NRC comments pertaining to the Volcanic Disruption of Waste Package model abstraction. No NRC/DOE agreements were needed in this area. The NRC noted that comment DIRECT1.1.1 and 1.1.2 address concerns that were discussed during the June 21-22, 2001, technical exchange and management meeting on Igneous Activity. NRC proposed agreements in these areas, but NRC and DOE were not able to reach agreement. These items will be kept open and the NRC and DOE plan to discuss them again in a future Igneous Activity meeting.

DIRECT2 - Airborne Transport of Radionuclides

NRC and DOE discussed the NRC comments pertaining to the Airborne Transport of Radionuclides model abstraction. No NRC/DOE agreements were needed in this area. The NRC noted that comment DIRECT2.2.1 and 2.TT.1 address concerns that were discussed during the June 21-22, 2001, technical exchange and management meeting on Igneous Activity. During the June meeting, NRC and DOE reached agreements in these areas.

DOSE1 - Dilution of Radionuclides in Groundwater due to Well Pumping

NRC and DOE discussed the NRC comments pertaining to the Dilution of Radionuclides in Groundwater due to Well Pumping model abstraction. No NRC/DOE agreements were needed in this area.

If information from the Supplemental Science and Performance Analyses (SSPA) Report, Rev 00, ICN 01 is used to support a potential licensing application, that information would have the appropriate quality assurance pedigree.

DOSE2 - Dilution of Radionuclides in Soil

NRC and DOE discussed the NRC comments pertaining to the Dilution of Radionuclides in Soil model abstraction. One specific NRC/DOE agreement was reached in this area (see Attachment 1 - TSPAI Agreement 3.33). The NRC noted that comment DOSE2.2.2, 2.3.1, 2.3.2, and 2.5.1 address concerns that were discussed during the June 21-22, 2001, technical exchange and management meeting on Igneous Activity. During the June meeting, NRC and DOE reached agreements in these area, except for comment DOSE2.5.1, for which NRC proposed an agreement but DOE did not agree to; this item will be addressed at the future Igneous Activity meeting as previously discussed.

DOSE3 - Lifestyle of Critical Group

NRC and DOE discussed the NRC comments pertaining to the Lifestyle of Critical Group model abstraction. Four specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.34 through 3.37). The NRC noted that comment DOSE3.1.1 addressed a concern that was discussed during the June 21-22, 2001, technical exchange and management meeting on Igneous Activity. During the June meeting, NRC and DOE reached an agreement in this area.

General Comments Pertaining to all the Model Abstractions

NRC and DOE discussed the NRC comments pertaining to general issues of transparency and traceability (TSPA001), methodology of model abstraction (TSPA002), procedures of model abstraction simplifications (TSPA003), and process model support (TSPA004). It was noted that the overall binning of examples was acceptable, except that a number of examples binned under “CAT1" should be binned under “CAT5." Four specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 3.38 through 3.41).

Other Issues

The NRC also discussed four FEPs (see items 30, 40, 45, and 46 from Attachment 2) which were initially presented at the May 15-17, 2001, TSPAI meeting. During the May meeting, the NRC and DOE agreed to delay discussions of these items until the next TSPAI meeting. For Item 30, the NRC stated that the FEP is appropriately addressed under CLST Agreement 1.11. For Item 40, the NRC stated that the FEP is appropriately addressed under CLST Agreement 3.7. For Item 45, the NRC stated that it is currently reviewing information pertaining to this FEP and that, if necessary, NRC would formally request additional information from DOE. For Item 46, the NRC stated that the FEP was discussed in an NRC letter dated August 3, 2001, related to Structural Deformation and Seismicity KTI and did not need to be addressed at this meeting.

7) Overall TSPAI Subissue 3 Status

Overall, the NRC and DOE reached 42 agreements for TSPAI Subissue 3 (see Attachment 1 for complete list of agreements for Subissue 3). The NRC stated, however, that since concerns associated with igneous activity remain open, TSPAI Subissue 3 must remain open. If, at a future Igneous Activity Technical Exchange and Management Meeting, these concerns are appropriately addressed by DOE and Igneous Activity Subissue 2 gets classified as “closed-pending,” TSPAI Subissue 3 can move to a “closed-pending” status.

8) TSPAI Subissue 1 - Multiple Barriers

DOE provided an overview of its proposed multiple barrier approach (see “Total System Performance Assessment and Integration Key Technical Issue Subissue 1 - Multiple Barriers” presentation given by Srikanta Mishra). DOE stated that the objectives of the presentation were to describe the process and techniques for multiple barrier analysis. DOE discussed the NRC proposed draft regulations pertaining to multiple barriers and the multiple barrier acceptance criteria outlined in the TSPAI Issue Resolution Status Report, Revision 3. NRC noted that in the Concepts Section for proposed 10 CFR 63.102(h), it states that “it is intended that natural barriers and the engineered barrier system work in combination to enhance the resiliency of the geologic repository and increase confidence that the post-closure performance objective will be achieved.” NRC also noted that the proposed regulations require that DOE needs to describe the capability of barriers important to waste isolation, taking into account uncertainties in characterizing and modeling the barriers. With respect to issue resolution, NRC stated that it would be just reviewing the methodology portion of multiple barriers and that it

would not be making any decisions regarding whether multiple barriers have been adequately identified by DOE or whether DOE has demonstrated multiple barriers are present.

DOE discussed its definition of a barrier and stated that (1) it is a physically distinct component that prevents or substantially delays movement of water or radionuclides and (2) it isolates waste by reducing mass and/or concentration. DOE stated process model factors are not barriers, but considerations affecting the barriers. DOE discussed its barrier importance analysis techniques, specifically, intermediate performance analysis, pinch-point analysis, robustness analysis, and neutralization analysis. A discussion of each follows below.

DOE stated that intermediate performance analysis involves a review of TSPA model results to look at intermediate outputs and provides insight into how different components contribute to total system performance. NRC noted the importance of focusing on performance during the regulatory compliance period.

DOE stated that pinch-point analyses are where the output of TSPA is processed at defined interfaces to provide indications of subsystem performance. DOE stated that pinch points occur where outputs (material, energy, or information flow) from one module of the total system become the inputs to another module. NRC questioned the difference between pinch-point and intermediate analysis results. DOE stated that there is a slight difference, intermediate results are graphical displays of TSPA outputs, pinch-point results are tabular and involve further analyses of intermediate results to show the relative contribution from a barrier.

DOE stated that robustness analysis examines what happens when the system is stressed via unfavorable parameter values and/or conceptual models of low probability. Results from these analyses indicate whether uncertainty in representing the barrier is significant with respect to predicting system performance. NRC questioned what the purpose of DOE's robustness analyses was. DOE stated that the robustness analyses was intended to provide insight into the performance of the model under unlikely conditions.

DOE stated that neutralization analysis is used to determine the importance of individual barriers. This analysis is an extreme form of robustness where the barrier remains in place, but its ability to retard and/or attenuate water and/or radionuclide movement is completely ignored.

DOE then discussed the comparison of barrier analyses. DOE stated that the pinch-point and intermediate performance analyses were more appropriate for: (1) showing capability of individual barriers to prevent or substantially delay movement of radionuclides, and (2) showing individual barrier contributions to waste isolation. In addition, DOE stated that robustness and neutralization analyses were more appropriate for: (1) differentiating contributions of barriers that perform similar functions, (2) examining impact of extreme scenarios, and (3) corroborating reasonable assurance arguments. NRC questioned how DOE planned to do barrier analyses with respect to individual radionuclides. DOE stated that it was still looking at the right set of analyses which will give the necessary information.

The NRC and DOE then discussed the NRC comments pertaining to multiple barriers. Two specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 1.01 through 1.02). With these agreements, NRC stated that TSPAI Subissue 1 could be classified as closed-pending.

9) NRC Presentation on Verification and Validation

The next two NRC presentations focused on the area of validation and verification of TSPA results. In the first presentation, NRC presented a regulatory perspective on model validation and computer code verification (see "Model Validation and Computer Code Verification: NRC Regulatory Perspective" presentation given by Michael Lee). NRC first noted that the traditional method of so-called "scientific validation" was not sought for the purposes of demonstrating compliance with NRC's proposed Yucca Mountain regulation. Rather, what was desired was that within the context of existing scientific principles, that DOE describe those "confidence building measures" or independent lines of evidence (e.g., tests, experiments, or natural analogue studies) that it would rely on to confirm that repository systems would perform as expected. As an example of an acceptable approach to confidence building, the NRC/Swedish Nuclear Power Inspectorate (SKI) Validation White Paper, NUREG-1636, was cited. NRC noted that this White Paper was not intended to represent formal staff guidance on the subject, nor was it intended as a *de facto* staff position. Rather, based on the views of the respective authors as well as a review of the international experience in this regard, the White Paper identified the types of information regulators might generally expect to find in an acceptable confidence building approach. In this regard, it was noted that the most important element of any acceptable approach was a confidence building strategy (and associated plan) that focused on those systems/processes determined by the repository developer to be most important to performance. Such an approach is intended to ensure that those systems/processes considered to be most important to performance would be expected to receive the greatest amount of confidence building by the repository developer. The NRC noted during the presentation that any DOE approach to confidence building should be consistent with its Repository Safety Strategy, currently under revision by DOE, or some higher-order planning document that describes DOE's broad philosophy in this area. NRC also noted that it intended to incorporate the White Paper concepts into the NRC Yucca Mountain-specific review plan, currently under development. During the question/comment period that followed, DOE noted that NRC should also consider the recent recommendations of the Nuclear Energy Agency as they relate to building confidence in TSPAs. The NRC concluded with a brief discussion of computer code verification. In response to a question from DOE, the NRC staff noted that the iterative nature of the performance assessment process generally leads to the evolution of a validation/verification process for TSPA models that occurs in parallel, rather than serially. Nevertheless, the NRC expressed the view that some minimum level of TSPA model validation was first necessary to establish before undertaking widespread computer code verification.

In the second presentation, NRC expanded on the model validation and computer code verification themes introduced above, as well as summarized the results of the staff reviews in these areas (see "Verification and Validation: Staff Reviews and Comments" presentation given by Sitakanta Mohanty). NRC first discussed some working definitions for software verification and model validation. NRC stated that verification (software) provides assurance that a computer code correctly performs the operations specified in a numerical model. NRC stated that validation (model) provides assurance that a model (e.g., conceptual or mathematical) as embodied in a computer code is a correct representation of the process or system for which it is intended. The NRC discussed several aspects of what is involved in software verification and model validation.

The NRC discussed general findings with respect to software verification. NRC stated that DOE has the elements of verification in their TSPA-SR and supporting documents, but rigorous verification has yet to be accomplished. NRC also presented a number of specific verification findings. In discussing a possible path forward, NRC stated that DOE should provide a plan/strategy to verify and document the calculations and computer codes supporting TSPA, including, minimum requirements for completing verification.

NRC next discussed its general findings with respect to model validation. NRC stated that DOE's model validation efforts are ineffective due to (1) failure to consistently implement quality assurance program requirements, and (2) lack of effective independent verification and validation. NRC stated that DOE's validation efforts are too limited and that its use of peer review is not a good substitute for objective information that is reasonably available. As a path forward, NRC recommended that DOE define a model validation plan/strategy and that this plan/strategy should include the following attributes: (1) theoretical support for models, and (2) additional lines of support (natural analogs, field tests, laboratory studies). DOE asked whether the NRC believes there should be one comprehensive plan. NRC stated that it does not have any particular preference. DOE questioned what the NRC meant by constituent model. NRC stated that it meant individual component models.

10) TSPAI Subissue 4 - Overall Performance Objective

DOE provided an overview of its proposed overall performance objective approach (see "Total System Performance Assessment and Integration Key Technical Issue Subissue 4 - Overall Performance" presentation given by Jerry McNeish). DOE stated that the objectives of the presentation were to (1) present the important aspects of TSPA software and model verification and validation and, (2) discuss the stability of overall performance results and the discretization of the TSPA model. DOE then discussed the five acceptance criteria for the Overall Performance subissue. NRC stated that the acceptance criteria associated with the demonstration that the average annual dose meets regulatory limits will not be addressed by the NRC during pre-licensing. The NRC also noted that for issue resolution during pre-licensing, it would only look at the methodology aspects of the subissue. The NRC indicated that the DOE delta-table did not reflect the NRC statement regarding the alternate design acceptance criterion (a copy of the NRC statement is included in Attachment 6).

In the next part of the presentation, DOE discussed TSPA software verification and stated that verification ensures that software performs as intended. DOE stated that a review of the GoldSim software, which is used for development of the TSPA model, found adequate software configuration control and verification.

DOE discussed its verification testing and stated that the documentation needs to be improved to show what steps DOE has taken to verify the model. DOE then discussed TSPA model validation and stated that the validation of a system model involves both submodel and integrated model validation. DOE stated that the supporting submodels are validated prior to implementation into TSPA. NRC questioned how DOE was using natural analogs to validate the TSPA model. DOE stated that sufficient data was available on the Pena Blanca site to help validate larger portions of the TSPA model. NRC asked when the methods and assumptions report would be available to the NRC. DOE stated that its intention is to complete it in fiscal year 2002.

DOE then discussed the stability of analyses and calculations and stated that a multiple replicate sample approach is being considered to demonstrate stability going forward. NRC asked if DOE was looking at various statistical measures to analyze the stability of analyses. DOE responded that going forward, they are looking at the multiple replicate sample approach and using statistical analyses to compare the results to assist in this area.

NRC asked if a systematic approach has been used for identifying appropriate distribution functions for representing uncertainty in data used in the TSPA model. DOE responded that a systematic approach for the selection of distribution function across all uncertain parameters was not used. The selection appeared to have been based on the modeler's best judgment and the selection documented in the AMRs.

Lastly, the DOE discussed the discretization of the TSPA model and stated that the TSPA-SR model used spatial/environmental binning and selected timesteps. DOE stated that alternative design analyses, along with multiple barrier analysis, should aid in comparative evaluation of alternatives to the major design features.

11) TSPA Management Plan

DOE provided the status of the DOE review associated with TSPA-SR discrepancies (see "Status - Total System Performance Assessment Issues" presentation given by Bob Andrews). DOE stated that during the presentation, it would address its TSPA vertical review, data qualification, software qualification, and model validation.

DOE discussed its approach to the TSPA vertical review and stated that its goals were to determine that the TSPA conclusions were supported. The findings from the management review were binned into four categories: (1) significant items (Category 1), (2) important items (Category 2), (3) weak basis/assumptions/reference (Category 3), and (4) minor errors (Category 4). DOE then discussed the status of the review and stated that it had not found any impact to date that affects the technical results to the conclusion that doses are within limits during the regulatory period. The NRC asked if the vertical review of the TSPA included the TSPA model (implemented in GoldSim). DOE stated that while the TSPA model was not a formal part of the evaluation, it was consulted when technical reviewers had questions.

DOE then discussed data qualification. DOE provided the current status of its data qualification effort and stated that the impact assessments would be provided to the NRC by the end of August 2001. DOE stated that to date, impact assessment activities indicate that incomplete and to-go data qualification actions have little or no impact on the AMR output. NRC asked if assumptions are considered data. DOE stated no. NRC asked how assumptions with the to be verified (TBV) label will be treated. DOE responded that assumptions are not part of the impact assessments but they are part of ongoing work to evaluate prior to any potential license application. DOE stated that the impact assessments for data will address (1) what data are unqualified or to be verified, (2) how data are used in AMRs that support the TSPA, (3) what is the output of the AMR, and (4) what is the impact and significance on the AMR output due to use of unqualified data.

DOE then discussed software qualification and provided the current status of its qualification efforts. DOE stated that the software impact assessments will address (1) how is the code used in the AMR that supports the TSPA, (2) what was the issue associated with code qualification, (3) what relative influence did the deficiencies have on the output of the AMR, and (4) was the technical adequacy of the AMR affected. DOE stated that codes supporting TSPA-SR that have impact assessments are scheduled to be qualified by the end of 2001.

Lastly, DOE discussed model validation and described the steps taken to assure that model validation supports confidence in the conclusions of the TSPA-SR. DOE stated that all the models that are not readily validated will have an impact assessment developed. NRC asked whether DOE would define what is an analyses and what is a model in the next revision to Procedure AP-3.10Q. DOE answered yes. In response to an earlier question by the NRC, DOE provided a discussion of the role, scope, and results of the Product Enhancement Review Group (PERG).

After further discussions, DOE stated that it is completing a set of comprehensive root cause analyses of quality-related issues resulting from evaluations of the TSPA-SR, software verification, and model validation. As a result of these analyses, DOE will implement a project-wide corrective action plan affecting processes that control the development of technical documents. The agreement items proposed by NRC are related to process implementation issues, including process control, human performance, management and supervision, and review and oversight activities. As part of that corrective action planning, DOE will address the broader causal factors that will include process and implementation practice changes. The results of the DOE root cause analyses and corrective action plans will be available, as they are developed, for NRC review beginning in September 2001. These actions will be discussed and tracked via the quarterly NRC/DOE Management and Quality Assurance meetings.

12) Specific NRC Overall Performance Objective Comments

NRC and DOE discussed the NRC comments pertaining to overall performance objective. Seven specific NRC/DOE agreements were reached in this area (see Attachment 1 - TSPAI Agreements 4.01 through 4.07). With these agreements, NRC stated that TSPAI Subissue 4 could be classified as closed-pending.

13) Public Comments

Judy Treichel (Nevada Nuclear Waste Task Force) expressed a concern about the amount of uncertainty in the results of the DOE performance assessment and asked about the amount of uncertainty that NRC would permit in the dose calculation and about the amount of uncertainty that NRC would permit and still close the subissue. NRC indicated that it has not reviewed the DOE dose calculation, but that a number of NRC questions relate to the concerns that she had expressed, and these comments would be discussed during the meeting.

In a latter session, Ms. Triechel stated that she was concerned with the use of proposed 10 CFR Part 63 and that the public had numerous comments and concerns about it. She noted that the public needed to have confidence in the models used for TSPA and from the discussions she did not have this confidence. Ms. Triechel stated that she was worried about the use of waste package and waste forms as barriers. NRC responded that proposed 10 CFR

Part 63 requires one natural and one engineered barrier and that DOE must show the capabilities of the barriers credited in its analyses. Ms. Triechel disagreed with the use of a 10,000 year compliance period and stated that the regulations should just focus on the dose to the public. Lastly, she stated that the definition of success for the NRC is not having a repository at Yucca Mountain. The NRC cannot just rely on probabilities, but must ensure public health and safety.

Mr. John Kessler (EPRI) stated that he was pleased with the NRC questions regarding consistency and integration in the performance assessment. He further commented that it was hard to tell if the NRC was more concerned with 0-10,000 years or greater than 10,000 years. NRC stated that its proposed regulations are expected to require 10,000 year compliance and its questions beyond this timeframe were intended to understand DOE figures and discussions. Mr. Kessler further stated that when performing neutralization analyses, one has to be very clear on what is being neutralized and how it is being done. Lastly, Mr. Kessler noted that he dislikes the use of the term “validation” by the NRC and that he prefers “confidence building” because of the level of disagreements that exist among scientists on the topic.

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